Table 5. Aries uplink interference to the radionavigation-satellite service

- Maximum permissible interference-to-noise power ratio in aircraft GLONASS receiver due to one Aries uplink (Note 1) . . . . -10 dB
- GLONASS receiver noise power density: . . . . -200 dBW/Hz
- Estimated maximum potential GLONASS processing rejection of Aries signals (Note 2): . . . . 20 dB
- Permissible single-entry interference: . . . . -190 dBW/Hz
- Aries user terminal EIRP density toward GLONASS receiver (Note 3): -33 dBW/Hz
- GLONASS receiver antenna gain toward Aries user terminal: . . . . 0 dBi
- Required basic transmission loss: . . . . 157 dB
- Required separation distance (Note 4): . . . . 500 km (312 miles)

Note 1: Several Aries uplinks could simultaneously interfere with a GLONASS receiver. A single interference power entry that is 10 dB less than the noise power level causes a 0.6 dB reduction in the effective signal-to-noise power ratio. Thus, the interference criteria assumed for GLONASS may be insufficiently protective.

Note 2: GLONASS operates with spread spectrum signals. The amount of processing gain (if any) to be applied with respect to Aries signals is uncertain.

Note 3: From Application, Appendix J.

Note 4: Assumed that earth blockage provides adequate attenuation.

Table 6. Aries interference to AMS(R)S uplinks to geostationary MSS systems

- Aries uplink EIRP per user (Note 1): . . . . 3 dBW
- Number of Aries channels that are co-channel with the AMS(R)S channel (Note 2): . . . . 2 (3 dB)
- Basic transmission loss to the geostationary satellite orbit: . . . . 188 dB
- Geostationary MSS satellite antenna gain (Note 3): . . . . 31 dBi
- Received interference power: . . . . -151 dBW
- Geostationary MSS Desired Signal Power (Note 4):

- Nominal	-152.0 dBW
- Threshold	-154.8 dBW

- C/I Ratio (Nominal C): . . . . -1.0 dB
- C/I Ratio (Threshold C): . . . . -3.8 dB

Note 1: CCI Application, Appendix H, at 9.

Note 2: Aries uplinks uses FDMA with narrowband channels, two of which could overlap the AMS(R)S channel.

Note 3: Each of the beams of the assumed geostationary MSS satellite (Note 2) would have a nominal gain of 31 dBi.

Note 4: Geostationary MSS system parameters are for an ICAO-standard C-channel operating at a 10.5 kbps information rate.

Table 7. Capacity of Aries for service to CONUS

• Aries full-load capacity:	50 channels
• Capacity available during Eclipse:	>20% (disregarded)
• Percentage of requested spectrum resources available under CCI multiple entry plan:	71.4% (disregarded)
• Capacity adjustment for conformance with PFD limit (Note 1):	52.5%
• Capacity adjustment from additional PFD reduction needed to prevent harmful interference to fixed service (Note 2):	10.0%
• Capacity adjustment for achievement of appropriate link power margins (Note 3):	50.0%
• Net available capacity:	1.9%
• Achievable full-load capacity (Note 4):	≈1 channel

Note 1: See Table 1.

Note 2: See Table 4.

Note 3: The Aries downlink power budgets provide between 1.4 dB and 2.9 dB of margin for propagation losses in excess of free space levels and for other degradations not manifest in the link budgets. An additional 3 dB of power is assumed to be needed in the downlink to enable potentially salable services.

Note 4: Voice activity factor of 1.5 is included; thus voice communications using Aries is not feasible.

Table 8. Separation distance needed between an Odyssey user and a radio astronomy observatory

- Odyssey mobile earth station uplink EIRP (Note 1): . . . . 0.5 dBW/5 MHz
- Antenna discrimination toward radio astronomy receiver site: . . . . 0 dB
- Interfering EIRP density (Note 2): . . . . -23.4 dBW/20 kHz
- Radio astronomy observatory antenna gain towards Odyssey user: . . . . 0 dBi
- Permissible single-entry interference power (Note 3): . . . . -230.0 dBW
- Required basic transmission loss: . . . . 206.6 dB
- Required separation distance (Note 4): . . . . 650 km (406 miles)

Note 1: A value near the minimum EIRP is assumed, consistent with an aircraft user under most power control conditions. See TRW Erratum, Table IV-D.

Note 2: The spectral line bandwidth being observed is 20 kHz, according to CCIR Report 224-7. Thus, the interfering EIRP is reduced in proportion to the ratio of signal and receiver bandwidths.

Note 3: CCIR Report 224-7 indicates that the total permissible interference to the radio astronomy observatory is -220 dBW. However, because numerous Odyssey users may be operating in the radio astronomy band at separation distances on the order of several hundred miles, no individual interferer should be allocated more than a small percentage of the total permissible interference. Here, it is assumed that a single interferer may contribute up to 10% of the total interference.

Note 4: Estimated by interpolation among curves in CCIR Recommendation 528-2 for 50% of the time and for antenna heights of 15 meters (radio astronomy observatory) and 20,000 meters (aircraft).

Table 9. Odyssey interference to receivers in the fixed service

• Odyssey PFD towards the Earth horizon:	-147 dBW/m^2/4 kHz	
• Effective aperture of fixed receiver antenna (Note 1):	11.6 dBm^2	
• Received interference power:	-135.4 dBW/4 kHz	
• Fixed service modulation	Analog	Digital
• Permissible level of interference (Note 2):	-148 dBW/4 kHz	-162 dBW/4 kHz
• Required fixed antenna discrimination:	12.6 dB	26.6dB
• Fixed antenna off-axis angular region where permissible interference is exceeded (Note 3):	3.5°	12.7°

Note 1: Based on antenna gain of 37 dBi, as prescribed in CCIR Report 382.

Note 2: Based on parameters given in CCIR Report 382.

Note 3: Based on $38-25\log\Theta$ pattern of CCIR Report 614. The sidelobe suppression requirements of the FCC would yield larger required off-axis angles.

Table 10. Odyssey uplink interference to the radionavigation-satellite service

• Maximum permissible interference-to-noise power ratio in aircraft GLONASS receiver due to one Odyssey uplink (Note 1):	-10 dB
• GLONASS receiver noise power density:	-200 dBW/Hz
• Estimated maximum potential GLONASS processing rejection of Odyssey signals (Note 2):	20 dB
• Permissible single-entry interference:	-190 dBW/Hz
• Odyssey user terminal EIRP density toward GLONASS receiver (Note 3):	-58 dBW/Hz
• GLONASS receiver antenna gain toward Odyssey user terminal:	0 dBi
• Required basic transmission loss:	132 dB
• Required separation distance:	59 km (37 miles)

Note 1: Several Odyssey uplink could simultaneously interfere with a GLONASS receiver. A single interference power entry that is 10 dB less than the noise power level causes at 0.6 dB reduction in the effective signal-to-noise power ratio. Thus, the interference criteria assumed here for GLONASS may be insufficiently protective.

Note 2: GLONASS operates with spread spectrum signals. The amount of processing gain (if any) to be applied with respect to Odyssey signals is uncertain.

Note 3: An Odyssey terminal located on the ground and operating at maximum EIRP is assumed. According to TRW's Erratum, at 3 and Table B-8, the chip rate is 2.5 megachips/sec. and the EIRP is 9 dBW. The bandwidth of the main emission lobe is 5 MHz, thus indicating an EIRP density of at least -58 dBW/Hz. This is consistent with TRW's stated maximum power density delivered to the antenna of -61 dBW/Hz (Application, Appendix E, at E-2).

Table 11. Odyssey interference to AMS(R)S uplinks
to geostationary MSS systems

- Odyssey average uplink EIRP per user (Note 1): .... 2.4 dBW/5 MHz
- Number of co-channel Odyssey uplinks from user terminals located in an MSS spot beam (Note 2): .... 201 (23 dB)
- Basic transmission loss to the geostationary satellite orbit: .... 188 dB
- Geostationary MSS satellite antenna gain (Note 3): .... 31 dBi
- Received interference power: .... -131.6 dBW/5 MHz
- Geostationary MSS On-Tune-Rejection of Odyssey signal (Note 4): ...... 25.8 dB
- Average Interference Power Level: .... -157.4 dBW
- Geostationary MSS Desired Signal Power (Note 4):

- Nominal	-152.0 dBW
- Threshold	-154.8 dBW

- C/I Ratio (Average I, Nominal C): .... 5.4 dB
- C/I Ratio (Peak I, Threshold C): .... --4.5 dB

Note 1: The average value of Odyssey uplink EIRP used among numerous mobile earth stations is given in TRW's Erratum, at Table C-2. The peak EIRP per user is 9.5 dBW, giving a peak-to-average EIRP ratio of 7.1 dB.

Note 2: TRW estimates that 402.5 Odyssey uplinks would be active simultaneously within the same receive beam of a four-beam CONUS coverage geostationary satellite (TRW Erratum, at Table C-3). Given that about four Odyssey satellite beams would fit within the assumed geostationary satellite antenna beam, on the order of one-half of the assumed Odyssey uplinks (i.e., 201 uplinks) would be co-channel.

Note 3: Each of the beams of the assumed geostationary MSS satellite (Note 2) would have a nominal gain of 31 dBi.

Note 4: Geostationary MSS system parameters are for an ICAO-standard C-channel operating at a 10.5 kbps information rate.

Table 12. Capacity of proposed Odyssey system in North America

- Capacity claimed for Odyssey: . . . . 4600 voice channels (N. America)
- Reduction in capacity from confinement of uplinks to the 1616.5-1626.5 MHz band (Note 1): . . . . 0.5806 (factor)
- Reduction in capacity from conformance with current PFD limit: . . . . 0.1995 (factor)
- Sub-total of adjusted capacity: . . . . 533 voice channels
- Further reduction in capacity from additional PFD reduction to preclude interference to fixed service (Note 2): . . . . 0.1 (factor)
- Net adjusted capacity: . . . . 53 voice channels

Note 1: TRW's frequency plan requires 0.5 MHz of guard bands between each pair of sub-bands. Thus, 1 MHz of the available bandwidth is used for guard band. It is assumed that a three-sub-band frequency plan would be used in the available 10 MHz.

Note 2: In order to ensure that Odyssey downlink emissions will exceed fixed service permissible levels of interference power for only negligible percentages of time, Odyssey PFD levels may have to be confined to at least 10 dB below the current PFD limit.

Table 13. Ellipso II Uplink EIRP

- Uplink EIRP Density User (Note 1): . . . . 11.0 dBW
- Number of Users Per Channel (Note 2): . . . . 20 (13 dB)
- Signal Bandwidth: . . . . 1.13 MHz
- Total Uplink EIRP Density: . . . . -0.5 dBW/4 kHz
- Uplink EIRP Limit: . . . . -3.0 dBW/4 kHz
- Amount of Violation: . . . . 2.5 dB

Note 1: Parameters are for an Ellipso Ground Control Station ("GCS"). Ellipsat Application, Appendix B, at 2.

Note 2: Ellipsat states that each frequency segment in the Ellipso II satellite transponder is capable of supporting 20 simultaneous CDMA carriers. Application, at 33. This implies that a GCS station may transmit up to 20 co-channel CDMA signals.

Table 14. PFD Produced by Ellipso II Satellites

- Ellipso II satellite EIRP per User (Note 1): . . . . 13.0 dBW
- Number of Users per Channel (Note 2): . . . . 20 (13 dB)
- Total EIRP (main beam): . . . . 26 dBW
- Ellipso II satellite antenna discrimination towards points having 5° elevation to satellite (Note 3): . . . . 4.9 dB
- Slant-path range towards points having 5° elevation to satellite (Note 4): . . 4902 km
- Spreading loss: . . . . 144.8 dB/m^2
- Signal Bandwidth: . . . . 1.13 MHz
- Power Flux Density: . . . . -148.2 dBW/m^2/4 kHz
- RR Limit (5° elevation): . . . . -154.0 dBW/m^2/4 kHz
- Amount of Violation: . . . . 5.8 dB

Note 1: Ellipsat Application, Appendix B, at 1.

Note 2: Ellipsat Application, at 33. The maximum EIRP per user (13 dBW) is generated in the direction of the main beam axis.

Note 3: The half-power beamwidth of the Ellipso II satellite antenna in the elevation angle plane is 60°. Application, Appendix A, at 3. In this plane, the minimum gain (maximum discrimination) of the antenna towards points on the Earth at 5° elevation occurs at an off-axis angle of 49.3°, or 0.822 beamwidths.

Note 4: A satellite altitude of 2000 km is assumed.

Table 15. Separation distance needed between an Ellipso II earth station and a radio astronomy observatory

	GCS	Mobile
• Ellipso earth station:	GCS	Mobile
• Ellipso II uplink EIRP (Note 1):	-0.5 dBW/ 4 kHz	-13.5 dBW/ 4 kHz
• Antenna discrimination toward radio astronomy receiver site:	37.4 dB	0 dB
• Interfering EIRP (Note 2):	-30.9 dBW	-6.5 dBW
• Radio astronomy antenna gain towards Ellipso earth station:	0 dBi	0 dBi
• Permissible single-entry interference power (Note 3):	-230 dBW	-230.0 dBW
• Required basic transmission loss on interference path:	199.1 dB	223.5 dB
• Separation distance (Note 4):	211 km (132 miles)	680 km (425 miles)

Note 1: Values of EIRP towards the horizon are taken from Table 7 (GCS) and from Ellipsat Application, Appendix B, at 1. The CGS antenna (40 dBi gain, 9 meter diameter) is taken to be pointed at an Ellipso II satellite whose trajectory results in an average GCS antenna gain of 2.6 dBi towards the horizon (equivalent to 15° static elevation angle). The Ellipso II mobile earth station is assumed to be located in an aircraft.

Note 2: The spectral line bandwidth being observed is 20 kHz, according to CCIR Report 224-7.

Note 3: CCIR Report 224-7 indicates that the total permissible interference to the radio astronomy observatory is -220 dBW. However, because numerous Ellipso II users may be operating in the radio astronomy band, no individual interferer should be allocated more than a small percentage of the total permissible interference. Here, it is assumed that a single interferer may contribute up to 10% of the total interference.

Note 4: Required separation distance for the GCS earth station is estimated using the method of CCIR Report 238. Required separation distance for the mobile earth station is estimated by interpolation of curves in CCIR Recommendation 528-2 for 50% of the time and for antenna heights of 15 meters (radio astronomy observatory) and 20,000 meters (aircraft).

Table 16. Ellipso II interference to receivers in the fixed service

	Analog	Digital
• Ellipso II PFD towards the Earth horizon: . . . . -148.2 dBW/m²/4 kHz		
• Effective aperture of fixed receiver antenna (Note 1): . . . . 11.6 dBm²		
• Received interference power: . . . . -136.6 dBW/4 kHz		
• Fixed service modulation:	Analog	Digital
• Permissible level of interference (Note 2):	-148 dBW/ 4 kHz	-162 dBW/ 4 kHz
• Required fixed antenna discrimination:	11.4 dB	25.4 dB
• Fixed antenna off-axis angular region where permissible interference is exceeded (Note 3):	3.1°	11.4°

Note 1: Based on antenna gain of 37 dBi, as prescribed in CCIR Report 382.

Note 2: Based on parameters given in CCIR Report 382.

Note 3: Based on 38-25logΘ pattern of CCIR Report 614. The sidelobe suppression requirements of the FCC would yield larger required off-axis angles.

Table 17. Ellipso II uplink interference to radionavigation-satellite service reception

- Maximum permissible interference-to-noise power ratio in aircraft GLONASS receiver due to one Ellipso II uplink (Note 1) . . . . -10 dB
- GLONASS receiver noise power density: . . . . -200 dBW/Hz
- Estimated maximum potential GLONASS processing rejection of Ellipso II signals (Note 2): . . . . 20 dB
- Permissible single-entry interference: . . . . -190 dBW/Hz

	GCS	Mobile
• Ellipso II EIRP density toward GLONASS receiver:	-36.5 dBW/Hz	-49.5 dBW/Hz
• GLONASS receiver antenna gain toward Ellipso II earth station:	0 dBi	0 dBi
• Required basic transmission loss:	153.5 dB	140.5 dB
• Separation distance (Note 3):	500 km (312 miles)	157 km (98 miles)

Note 1: Several Ellipso II uplinks could simultaneously interfere with a GLONASS receiver. A single interference power entry that is 10 dB less than the noise power level causes at 0.6 dB reduction in the effective signal-to-noise power ratio. Thus, the interference criteria assumed for GLONASS may be insufficiently protective.

Note 2: GLONASS operates with spread spectrum signals. The amount of processing gain (if any) to be applied with respect to Ellipso II signals is uncertain.

Note 3: For the CGS earth station, it is assumed that earth blockage provides adequate attenuation. Free space basic transmission loss is assumed for the mobile earth station case.

Table 18. Ellipso II interference to AMS(R)S uplinks to geostationary MSS systems

- Ellipso II GCS uplink EIRP (Note 1): . . . . -0.5 dBW/4 kHz
- AMS(R)S bandwidth (Note 2): . . . . 13.1 kHz
- Basic transmission loss to the geostationary satellite orbit: . . . . 188 dB
- Geostationary MSS satellite antenna gain (Note 3): . . . . 31 dBi
- Received interference power: . . . . -152.3 dBW
- Geostationary MSS Desired Signal Power (Note 2):

- Nominal	-152.0 dBW
- Threshold	-154.8 dBW

- C/I Ratio (Nominal C): . . . . 0.3 dB
- C/I Ratio (Threshold C): . . . . -2.5 dB

Note 1: See Table 13.

Note 2: Geostationary MSS system parameters are for an ICAO-standard C-channel operating at a 10.5 kbps information rate.

Note 3: Each of the beams of the assumed geostationary MSS satellite (Note 2) would have a nominal gain of 31 dBi.

Table 19. Capacity of Ellipso II for service to CONUS

- Ellipso II full-load capacity (2 sat.s): . . . . 1210 channels
- Capacity adjustment for conformance with PFD limit (Note 1): 26.3%
- Capacity adjustment from additional PFD reduction needed to prevent harmful interference to fixed service (Note 2): 10.0%
- Capacity adjustment for achievement of appropriate link power margins (Note 3): 31.6%
- Capacity adjustment to confine operations to frequencies above 1616.5 MHz: 50.0%
- Net available capacity: 0.42%
- Achievable full-load capacity (Note 4): . . . . ≈5 channels

Note 1: See Table 14.

Note 2: The additional 10dB reduction in the PFD of non-geostationary satellites may be sufficient to ameliorate interference to the fixed service.

Note 3: Ellipsat's GCS-to-mobile links have insufficient power margins; thus, an additional 5dB of power is assumed for these links. See Ellipsat Application, Appendix B, at 1.

Note 4: Implicit in the 5 channel capacity is Ellipsat's voice activity factor of 2.8.

DECLARATION

I, Thomas M. Sullivan, do hereby declare as follows:

1. I have a Bachelor of Science degree in Electrical Engineering and have taken numerous post-graduate courses in Physics and Electrical Engineering.

2. I am presently employed by Atlantic Research Corporation and was formerly employed by IIT Research Institute, DoD Electromagnetic Compatibility Analysis Center.

3. I am qualified to evaluate technical information in the Opposition of American Mobile Satellite Corporation. I am familiar with Part 25 and other relevant parts of the Commission's Rules and Regulations.

4. I received, in 1982, an official commendation from the Department of the Army for the establishment of international provisions for the worldwide operation of mobile earth stations.

5. I have served in the CCIR as Vice-Chairman of IWP-8/14, and chaired Working Groups in IWP-8/14 (Melbourne) and IWP-8/15 (Helsinki), that addressed detailed MSS frequency sharing matters in the CCIR for WARC-92.

6. I am familiar with the design and operation of non-geostationary spacecraft, and I am participating in the design of advanced data handling and transmission sub-systems for the NOAA-O,P,Q satellites and ground systems and the European Polar Orbiting Platform.

7. I am the engineer principally responsible for the current CCIR methods for coordinating frequency assignments and predicting actual levels of interference for systems using non-geostationary spacecraft.

8. I have first-hand experience in the international coordination of frequency

assignments for mobile satellite systems.

9. I have been involved in the preparation of and have reviewed the Opposition of American Mobile Satellite Corporation including frequency sharing analyses, and concur with the technical contents. The technical facts contained therein are accurate to the best of my knowledge and belief.

Under the penalties of perjury, the foregoing is true and correct.

October 16, 1991
Date

Thomas M Sullivan
Thomas M. Sullivan

CERTIFICATE OF SERVICE

I, Jacqueline L. Mateo, a secretary in the law firm of Fisher, Wayland, Cooper & Leader, hereby certify that a true copy of the foregoing "Opposition of American Mobile Satellite Corporation" was mailed by United States First Class Mail, this 16th day of October 1991 to the following:

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